Machine Learning for Engineering and Science Applications
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Covariance Matrix of Gaussian Distribution

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Small note about the covariance matrix of a Gaussian distribution.

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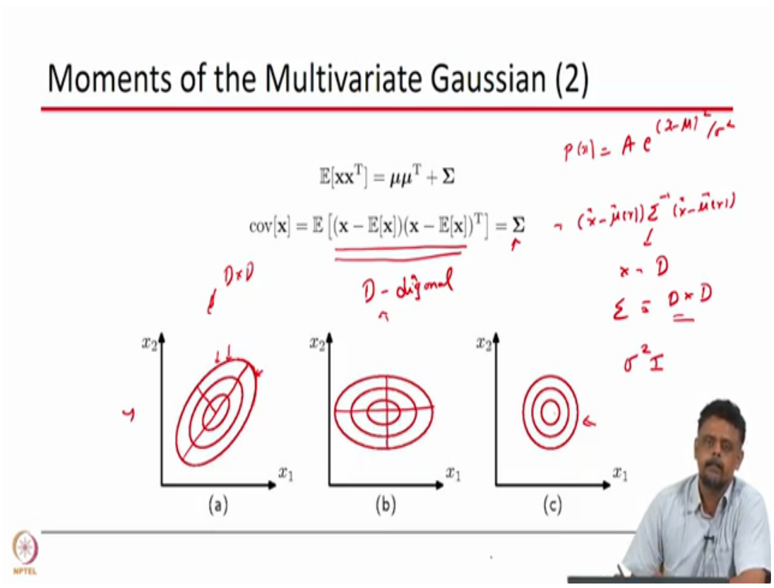

So we again the slides are from Dr. Christopher Bishop textbook PRML, so you are all familiar right now with the Univariate Gaussian where you know the probability density function is given by some normalizing constant and exponential x minus mu square by sigma squared for Multivariate Gaussian then we had this and then the exponent the terms I am just writing down the terms and the exponent where we had x minus mu of x and then we had the inverse of the covariance matrix and here again x and mu are vectors depending on the number of dimensions that you are operating in, ok.

Now if you take this covariance matrix ok of course it is the it is defined as the expectation of this quantity that is your covariance matrix and it is actually if you have D (demint) D dimensions capital D dimensional dimensions then if x is D dimensional variable then the covariance matrix as D cross D elements ok. So what is this what will it show you if there are different forms of this D cross D matrix ok.

So the first plot here corresponds to the most general form of D by D wherein all the elements are different, so which means that there is some correlation between the different features that you have and what is drawn here there are let us say we are looking at two dimensional variable and there are x 1, x 2 are your features ok then these lines correspond to lines of constant PDF ok, so then you can see that these are kind of like tilted ellipses.

So this is corresponding to a full D cross D matrix ok, here D is a diagonal matrix and every element the diagonal has a different value then you get a the lines of constant PDF will correspond to ellipse is like this and again the major and minor axis will did will tell you what the what the actual diagonal elements are they correspond these links would correspond to the this which should correspond to the size of the diagonal elements ok.

The third case is when it is it is again diagonally but then you can write the sigma squared I where all the diagonal elements are equal and then you have the lines of constant probability density are given by these circles ok, so if you plot the locus of constant density function there will be circles ok. So here in the most general case it means if this all this shows is that there is some correlation between the variables this of this kind of tilted way of drawing this tilted ellipses which are these each of these lines are correspond to constant PDF values, ok.

So if you plug in all the x, so all pairs of x 1, x 2 and on these lines evaluate to the same PDF ok so that is the that is what the contours we have drawn, so because if you think about it x1, x2 P of x1, x2 will be some will rise about the plane ok and then if we just project them onto the plane that these are the lines we will get we cut and project on to the link that is how links we get again, so there are three cases the most general case D cross D and D is a diagonal matrix but each diagonal element is different and here again diagonal but each of the diagonal elements are the same.